European Patent 0 174 624

Process for Production of Lactic Acid Esters **K. Bott et al. July 22, 1987**

Description

The present invention concerns a process for the preparation of an optically pure alkyl D- or L-lactate, wherein calcium lactate, produced by fermentation, is converted in the presence of a strong acid.

The fermentatative production of optically pure lactic acid is known from EP 0 069 291 or Ind. Eng. Chem. 44, 1958 (1952). It is carried out in the presence of calcium carbonate so that at the end of the reaction an aqueous solution or suspension results which contains approximately 6 to 20% calcium lactate along with different organic or inorganic impurities that were either additives for the fermentation or reaction byproducts produced during fermentation. In addition, biomass and, as the case may be, unused calcium carbonate are present as solids.

Finally, the lactic acid is separated from the calcium salt by acidification with sulfuric acid, during which gypsum precipitates out, which is filtered off along with the biomass. The filtrate is an aqueous lactic acid solution with an approximately 10% lactic acid content, which still contains different solubilized impurities. This solution normally is concentrated and undergoes appropriate purification processes.

The described procedure has different drawbacks. Significant quantities of calcium sulfate are produced which, because of the biomass it contains, tends toward side fermentation and, therefore, cannot be recovered without further treatment. Value as nutrients, for example, is not possible because of insufficient purity. Another drawback is that, through rinsing of the filter cake, there is further dilution of the aqueous lactic acid solution, which makes the isolation of the product, whether it is lactic acid or, in the event that alcohol is added during the separation from the calcium lactate, the lactic acid ester, more difficult. Finally, concentration of the aqueous lactic acid solution through distillation, for example, often produces problems since the rest of the biomass and, particularly, solubilized calcium sulfate, which increasingly precipitates, leads to fouling of equipment. Furthermore, a small portion of the lactic acid is lost with the water.

The invention, thus, led to the task of developing a process for the esterification of an optically pure lactic acid produced through fermentation, which circumvents the well-illustrated drawbacks and produces the ester with good yield and good optical purity.

Accordingly, a process was found to prepare optically pure alkyl D- or L-lactate by conversion of calcium lactate, prepared by fermentation, with an alcohol in the presence of a strong acid wherein the crude fermentation mixture is filtered, the calcium lactate is isolated as a solid from the filtrate by spray-drying and reacted with an alcohol in the presence of an acid which forms a readily water-soluble calcium salt, the water present in the reaction mixture or formed during the esterification as the case may be, is separated off by azeotropic distillation with the aid of an entraining agent and the lactic acid ester is isolated from the reaction mixture in a conventional manner.

The crude reaction mixture, stemming from fermentation, which contains D- or L-lactic acid as calcium lactate, is filtered to remove solids such as biomass or unused calcium carbonate. Thereby, it is important to hold the temperature of the solution high enough so that no calcium lactate precipitates out. As a rule, a temperature of 50 to 90, preferably 60 to 80°C, is used. The

filtration is carried out using conventional techniques, for example using filter presses and, if necessary, using filter aids such as silica gel.

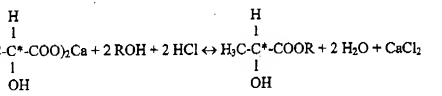
Finally, the filtrate is dried in a spray-dryer using heated air. The incoming air temperature is 280 to 300°C and the that of the outgoing air is 110°C. The success of this process step is surprising, considering that it could be assumed that the raw calcium lactate would be sticky due to the impurities it contains, and, thus, would not be flowable.

In fact, no noteworthy configuration change is noted at the activity center.

For esterification the calcium lactate is converted using a low molecular weight alcohol ROH in the presence of a strong acid. The alcohol can be branched or straight chain and contain 1 to 10, preferably 1 to 5, carbon atoms. Preferably, the reaction is run using secondary and primary alcohols, for example, ethanol, propanol, butanol, isobutanol, pentanol and isopentanol. Polyvalent alcohols such as glycol or glycerin also can be used.

Strong acids that can be used are those that form a highly soluble calcium salt and can be used as esterification catalysts. Nitric acid, HBr and sulfonic acids are recommended and hydrochloric acid, preferably in concentrated form, is especially well suited.

The outcome of this is the following reaction equation:



In order to shift the esterification weight balance to the right one of the output components, usually the less expensive one, is normally added in excess while the conversion products are removed from the reaction mixture.

For the invention procedure it is important to use the alcohol in excess, not only to shift the above illustrated weight balance but to keep the concentration of the balanced weight lactic acid ester dimers and trimers, formed through the reaction of lactic acid with the hydroxyl group of another lactic acid molecule, as small as possible. As a rule 2 to 4 moles of alcohol per mole of lactic acid are used.

In order to remove the water added along with the reaction components, whether in the form of aqueous hydrochloric acid or aqueous calcium lactate, which can still have a water content of 0 to 25% after spray-drying, and that produced during esterification, it is azeotropically distilled off in the presence of a processing aid such as cyclohexane or toluene.

In general, alcohols with 4 and >4 carbon atoms themselves form azeotropes with water such that, in certain cases, the addition of a processing aid is unnecessary. In the present case, however, the processing effectiveness of the alcohol in question is strongly decreased due to the presence of $CaCl_2$. For the invention procedure it is, therefore, important that even in these cases, for example with the use of isobutanol, a processing aid is added in order to avoid a considerable yield loss of high-value product due to a low degree of esterification.

In order to isolate the high-value product after esterification the accumulated reaction mixture is treated with water, whereby a salt-free organic phase and an aqueous salt phase develops. The extraction can be done continuously or batchwise using conventional techniques.

Finally, the organic phase is neutralized with diluted sodium hydroxide, for example, and the lactic acid ester purified by conventional methods, preferably under reduced pressure. The neutralization before the purification by distillation is advisable in order to avoid the subsequent accumulation of larger lactic acid esters (dimers, trimers).

According to the invention procedure the lactic acid ester is achieved with a good yield and a high optical purity.

Optically active lactic acid esters are important precursors in the production of optically active herbicides.

Example

A calcium lactate solution, produced by fermentation, was filtered in a filter press in the presence of silica gel as a filter aid and, subsequently, fed hot into a spray-dryer in which the incoming air temperature was 280°C and the outgoing air temperature was 110°C. 105 parts accumulated crude calcium lactate, which contained 67% lactic acid, was transferred with 203 parts isobutanol, 137 l toluene and 97 parts concentrated hydrochloric acid and heated for 5 hours under reflux. Thereby 82 parts water was removed. After cooling to room temperature 103 parts water were added and the aqueous calcium chloride-containing phase, approximately 154 parts, was separated off.

The organic phase was neutralized with 50% sodium hydroxide and subsequently processed by distillation.

The yield of optically active isobutyl lactate was 89%, corresponding to 120 parts, based on calcium lactate. The optical purity of the product was > 95%.

Claims

1. A process for the preparation of an optically pure alkyl D- or L-lactate by reaction of calcium lactate, prepared by fermentation, with an alcohol in the presence of a strong acid, wherein the crude fermentation mixture is filtered while hot, the calcium lactate is isolated as a solid from the filtrate by spray-drying and is reacted with an alcohol in the presence of an acid which forma a readily water-soluble calcium salt, the water present in the reaction mixture or formed during the esterification is separated off by azeotropic distillation with the aid of an entraining agent and the lactic acid ester is isolated from the reaction mixture in a conventional manner.

2. A process as claimed in claim 1, wherein the esterification is carried out in the presence of hydrochloric acid.

3. A process as claimed in claim 1, wherein a branched or straight-chain low molecular weight alcohol of 1 to 10, preferably 1 to 5, carbon atoms is used.

4. A process as claimed in claim 1, wherein the alcohol is added in an amount of from 1 to 5 moles per mole of lactic acid.

5. A process as claimed in claim 1, wherein filtration is carried out at from 50 to 90°C, in particular from 60 to 80°C.

6. A process as claimed in claim 1, wherein, in the spray-drying operation, the temperature of the incoming air is from 280 to 300°C and that of the outgoing air is 110°C.